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Orijinal Araştırma / Original Article

Comparison of Prognostic Computed Tomography Scores in Geriatric Patients with Traumatic Brain Injury: A Retrospective Study

Travmatik Beyin Hasarı Olan Yaşlı Hastalarda Prognostik Bilgisayarlı Tomografi Skorları Karşılaştırması: Retrospektif Bir Çalışma

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Abstract

Aim: This study aimed to compare the Rotterdam and Helsinki computed tomography (CT) scoring systems for predicting the 30-day mortality after traumatic brain injury (TBI) in the geriatric population.

Material and Method: Patients aged ≥65 years presenting to the emergency department with trauma-related complaints were retrospectively scanned using International Classification of Disease codes, and patients with isolated head trauma examined using brain CT were included. Demographic data including age, gender, trauma mechanisms, Glasgow Coma Scale (GCS) score at the time of admission, light reflex information, intubation, and surgery status, and emergency department outcomes were recorded. Brain CT images were investigated to calculate the Rotterdam and Helsinki CT scores and the relationship between them was examined.

Results: Of the 890 included patients, 403 (45.3%) were male. Overall, 683 patients fell from a height of <1 m and 195 suffered injuries by hitting or direct impact. Further, the 30-day mortality rate was examined, revealing that 868 patients were alive and 22 patients died. Mortality rate was 3.7% for males and 1.4% for females. The Rotterdam and Helsinki CT scores and 30-day mortality was analyzed using receiver operating characteristic curve analysis, and the area under the curve was found as 0.564 and 0.603, respectively. The specificity of Rotterdam and Helsinki CT scoring systems in predicting 30-day mortality was 99.08% and 99.19%, respectively.

Conclusion The use of CT scoring systems such as Rotterdam and Helsinki in the geriatric population presenting with TBI allows us to predict 30-day mortality.

Keywords: traumatic brain injury, geriatrics, emergency department, tomography

Öz

Giriş: Rotterdam Bilgisayarlı Tomografi (BT) skorlama ve Helsinki BT skorlama sisteminin geriatrik popülasyonda TBH (travmatik beyin hasarı) sonrası 30 günlük mortaliteyi tahmin etme yeteneklerinin karşılaştırmasını sağlamayı amaçlamaktadır.

Gereç ve Yöntem: Acil servise travma ilişkili şikayetlerle başvuran 65 yaş ve üstü hastalar ICD kodları üzerinden retrospektif olarak tarandı ve izole kafa travması mevcut olup beyin BT ile tetkik edilmiş olan hastalar çalışmaya dahil edildi. Hastaların yaş, cinsiyet gibi demografik verileri, travma mekanizmaları, geliş muayenesinde Glasgow Koma Skalası (GKS), ışık refleksi bilgileri, entübe edilip edilmediği ve opere olup olmadığı, acil servis sonlanım bilgisi taranarak kaydedildi. Hastaların beyin BT görüntüleri incelenerek Rotterdam ve Helsinki BT skorları hesaplandı ve bunlar arasındaki ilişkiye bakıldı.

Bulgular: Çalışmamıza dahil edilen 890 hastanın 403 (%45.3) erkekti. Çalışmamızda 683 hastanın 1 metreden daha düşük yükseklikten düştüğü, 195 tanesinin çarpma veya direkt darbe alma şeklinde olduğu görüldü. Hastaların bir aylık mortalite bilgisine bakıldığında 22 hastanın öldüğü ve 868 hastanın sağ olduğu saptandı. Erkek hastalarda ölüm oranı %3,7 iken kadın hastalarda bu oran %1,4 olarak bulunmuş olup mortalite açısından cinsiyetler arasında anlamlı fark saptandı. Hastaların Rotterdam ve Helsinki BT Skorları ve bir aylık mortaliteleri ROC analizi ile incelendiğinde Rotterdam BT Skoru için eğri altında kalan alan sırasıyla 0.564 ve 0.603 olarak bulundu. Hastaların Rotterdam BT Skoru ve Helsinki BT skoru 1 aylık mortaliteyi tahmin etmede spesifitesi sırayla %99,08 ve %99,19 olarak hesaplandı.

Sonuç: TBH ile başvuran geriatrik popülasyonda Rotterdam ve Helsinki gibi BT skorlamalarının kullanımı bize 30 günlük mortaliteyi tahmin etmemizi olanak sağlamaktadır.

Anahtar Kelimeler: travmatik beyin hasarı, geriatri, acil servis, tomografi

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INTRODUCTION

Traumatic brain injury (TBI) is one of the leading causes of morbidity and mortality worldwide. TBI is the cause of many emergency department admissions, hospitalizations, and 30% of injury-related mortality.[1-3] Along with the effect of age and declined physical function, one of the most common injury mechanisms in the geriatric population is falling.[4] Although the elderly population comprised 26.7% of the total population in developed countries in 2015, this ratio is expected to reach 40% in approximately 40 years.[5] Age is one of the most important prognostic factors for TBI. The geriatric population is shown to be at higher risk than younger patients in terms of length of hospital stay, cost, survival, and functional outcome.[2,5]

Computed tomography (CT) is a routine imaging method used to evaluate lesions in patients with acute TBI and to immediately initiate diagnosis and treatment due to its easy accessibility and rapid applicability.[6] This imaging modality not only allows the diagnosis of intracranial injuries but also provides prognostic information.[6,7] Several CT scoring systems are available to predict and categorize the mortality of patients with TBI. Rotterdam CT score and Helsinki CT score are the most frequently used scoring systems.[8,9] The Rotterdam CT scoring system is based on epidural mass lesion, midline shift, basal cistern morphology, and intraventricular blood or traumatic subarachnoid hemorrhage.[10] The Helsinki CT score is calculated based on the lesion type and volume, presence of intraventricular bleeding, and suprasellar cistern status.[11]

This study aimed to compare the ability of the Rotterdam and Helsinki CT scoring systems to predict the 30-day mortality after TBI in the geriatric population.

MATERIAL AND METHOD

Patients older than 65 years who presented to the emergency department of a tertiary education and research hospital with trauma-related complaints between January 01, 2018, the same date in 2021 were retrospectively analyzed using International Classification of Disease codes, and those with isolated head trauma who were examined using brain CT were included in the study. Patients aged <65 years, without head trauma, who did not undergo brain CT examination despite having head trauma, for whom brain CT findings could not be understood whether the cause or outcome such as head trauma during syncope or epileptic seizure, and those with missing data were excluded from the study. Demographic data including age, gender, trauma mechanisms (fall from height of <1 m, fall from height of >1 m, hit or direct impact, motor vehicle collisions, pedestrian injury, motorcycle accident), Glasgow Coma Scale (GCS) on admission, light reflex information, intubation and surgery status, and emergency department outcome were recorded. Rotterdam and Helsinki CT scores were calculated by examining the patients' brain CT images. The 30-day mortality status of the patients was confirmed by checking both the Death Notification System (ÖBS, http://www.obs.gov.tr) and hospital data. The study was carried out with the permission of Umraniye Training and Research Hospital Ethical Committee (ethics committee approval number: B.10.1TKH.4.34.H.GP.0.01/294). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Statistical Analysis

The collected data were analyzed using IBM SPSS 28 (IBM Corp. Released 2021; IBM SPSS Statistics for Macintosh, Version 28.0, Armonk, NY; Analyzed using IBM Corp). Continuous data with normal distribution were presented as mean and standard deviation, whereas continuous data without normal distribution were presented as median and interquartile range (IQR). Categorical data were expressed as frequency and percentage. Categorical data were compared using Chi-squared and Fischer's exact test where applicable. Continuous data that did not fit normal distribution were compared using Mann–Whitney U test. Receiver operating characteristic (ROC) curves were compared using the DeLong test. A p value of <0.05 was considered significant in all statistical analyses.

RESULTS

Overall, 7869 patients aged older than 65 who presented to the emergency department for trauma between the study period were scanned. Of these, we excluded 3839 patients due to lack of head trauma, 1229 as they did not undergo brain CT, and 1911 due to unclear mechanism of trauma and lack of data.

Of the remaining 890 patients included in the study, 403 (45.3%) were male. Median age was 77 (IQR: 71–84) years. On examining the trauma mechanisms of the patients, we found that 683 (76.7%) patients fell from a height of <1 m, 195 (21.9%) suffered a hit or direct impact, 2 (0.2%) fell from a height of >1 meter, 6 (0.7%) were in motor vehicle collisions, 3 (0.3%) were in pedestrian injury, and 1 (0.1%) was in a motorcycle accident. Patient examination at the time of admission showed that 873 (98.1%) patients had a GCS of 15, 13 (1.5%) had a score of 14, and 4 (0.4%) had a score of ≤13. Two (0.2%) patients had negative unilateral light reflex and anisocoria at the time of admission, and four (0.4%) were intubated in the emergency department. On investigating the emergency department outcomes of the patients, we found that 1 (0.1%) patient had died in the emergency room, 28 (3.1%) had been admitted to other wards, 3 (0.3%) were moved to the intensive care unit, and 858 (96.4%) were discharged from the emergency room. Examination of the 30-day mortality of the patients revealed that 22 (2.5%) patients had died and 868 (97.5%) were alive. Brain CT findings and other data of the patients are summarized in **Table 1**.

Table 1. Descriptive characteristics of patients

	n (%)
Gender	
Male	403 (45.3)
Female	487 (54.7)
Age	77 (71 – 84)
Trauma mechanism	
Fall from height of <1 m	683 (76.7)
Fall from height of >1 m	2 (0.2)
Hit or direct impact	195 (21.9)
Motor vehicle collisions	6 (0.7)
Pedestrian injury	3 (0.3)
Motorcycle accident	1 (0.1)
Glasgow Coma Scale	
15	873 (98.1)
14	13 (1.5)
≤13	4 (0.4)
Pupil status	
Isochoric	888 (99.8)
Anisochoric	2 (0.2)
Intubation in the emergency department	4 (0.4)
Emergency department outcome	
Discharged	858 (96.4)
Admitted to a hospital ward	28 (3.1)
Admitted to the intensive care unit	3 (0.3)
Death	1 (0.1)
30-day mortality	
Alive	868 (97.5)
Dead	22 (2.5)
Brain computed tomography findings	
Subdural hematoma	17 (1.9)
Epidural hematoma	2 (0.2)
Intracerebral hematoma	3 (0.3)
Subarachnoid hemorrhage	8 (0.9)
Intraventricular hemorrhage	0 (0.0)
Compressed cistern	2 (0.2)
>5 mm shift	1 (0.1)
>25 cm³ hematoma volume	2 (0.2)
Rotterdam scores	
1	879 (98.8)
2	9 (1.0)
3	2 (0.2)
4	0 (0.0)
5	0 (0.0)
6	0 (0.0)
Helsinki scores	
–1	1 (0.1)
0	865 (97.2)
1	0 (0.0)
2	15 (1.7)
3	6 (0.7)
4	0 (0.0)
5	3 (0.3)

Table 2. Comparison of 30-day mortality in terms of age, gender, and Rotterdam and Helsinki computed tomography scores

	Mortality		p values
	Dead	Alive	
Age	81 (IQR: 76.5 – 85.8)	77.0 (IQR: 70.8 – 84.0)	0.015*
Gender			
Male	15 (3.7)	388 (96.3)	0.029**
Female	7 (1.4)	480 (98.6)	
Rotterdam CT scores			
<2	19 (2.2)	860 (97.8)	0.002***
≥2	3 (27.3)	8 (72.7)	
Helsinki CT scores			
<3	20 (2.3)	861 (97.7)	0.019***
≥3	2 (22.2)	7 (77.8)	

P values written in bold are statistically significant (p < 0.05). *Mann–Whitney U test; **Chi-squared test; ***Fischer's exact test CT, computed tomography; IQR, interquartile range

An analysis of the relationship between age and mortality revealed that the median age of the patients who had died was 81 years (IQR: 76.5–85.8) and that of the surviving patients was 77.0 years (IQR: 70.8–84.0) (Mann–Whitney U test; p=0.015). The mortality rate was 3.7% for males and 1.4% for females (Chi-squared test; p=0.029). When the Rotterdam and Helsinki CT scores and 30-day mortality of the patients were analyzed using ROC analysis, the area under the curve for the Rotterdam CT score was 0.564 and that for the Helsinki CT score was 0.603 (**Figure 1**). The difference between the two AUC values was calculated as –0.04 (95% CI: –0.101–0.021); however, this difference was not statistically significant (De-Long test; p=0.203). When the Rotterdam CT score of the patients was dichotomized at the cutoff value of 2, 879 patients were found to have a Rotterdam CT score of <2 and 2.2% of these patients died, whereas 11 patients had a score of ≥2 and 27.3% of these patients died. This difference in the mortality rates was statistically significant (Fischer's exact test; p=0.002). At this cutoff value, the specificity of the Rotterdam CT score was 99.08% (95% CI: 98.19% vs. 99.6%). When the Helsinki CT score was dichotomized at the cutoff value of 3, 881 patients had a Helsinki CT score of <3 and 2.3% of these patients died, whereas 9 had a Helsinki CT score of ≥3 and 22.2% of these patients died. The difference between the mortality rates was found to be statistically significant (Fisher's exact test; p=0.019) (**Table 2**). At this cutoff value, the specificity of the Helsinki CT score was 99.19% (95% CI: 98.35%–99.68%).

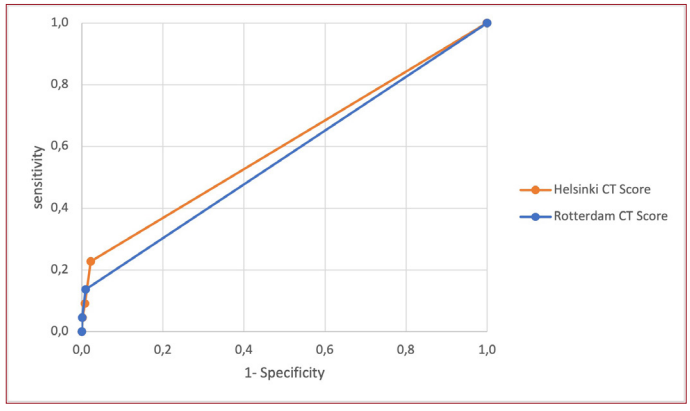

Figure 1. Receiver operating characteristic curves for Rotterdam and Helsinki computed tomography scores according to 30-day mortality

DISCUSSION

Predicting mortality is very important for patients with TBI. This helps clinicians decide the resource allocation for patients and communicate with the patient's relatives.[12] GCS is the most used scoring system to evaluate TBI and predict prognosis;.[13] however, it has some limitations, e.g., it does not consider brainstem reflexes and eye movements. GCS is not reliable for patients who consume alcohol or were given sedatives and cannot provide structural information for

intracranial lesions.[2,6,14] For these reasons, we compared the Helsinki CT scoring system with the Rotterdam CT scoring system, both of which are used to classify CT, to accurately predict prognostic values. The AUC for the Rotterdam CT scoring system was 0.564 and that for the Helsinki CT scoring system was 0.603, showing no significant differences. In mortality prediction, the sensitivity of both scoring systems was found to be >99%, which was statistically significant. When the scoring systems were individually evaluated, they were successful in predicting prognosis. No previous study in the literature includes geriatric patients.[7,11,15,16] We believe that these two scoring systems can be used to evaluate the 30-day mortality in the geriatric patient population presenting to the emergency department with TBI.

TBI-related admissions to the emergency department, ward, and intensive care units as well as mortality occur most frequently in older adults.[17] Increasing age is one of the most important prognostic factors for mortality in TBI.[2,17] In the present study, the median age of patients aged >65 years presenting to the hospital with TBI was 77 years, which is consistent with the literature.[18] It was found that the median age of the patients who died was 81 years and that of the patients who survived was 77 years. This difference was statistically significant. Differences after TBI is age-related. Morbidity and mortality increase with an increase in age,[2] which, in turn, leads to an increase in the length of hospital stay and cost of care.[2,3] Therefore, scoring systems that predict mortality may help clinicians predict the healthcare costs.

Although the number of women presenting to the emergency department with TBI was higher in the present study, the opposite was the case in terms of mortality, with a mortality rate of 3.7%, which is significantly higher compared with that for females. In the literature, some studies report that male patients more frequently present with TBI in all age groups, whereas some other studies report that the frequency of female patients is higher.[17-19]

According to our data, the most common reason for TBI in admitted patients was falling from the same level (76%). This is in accordance with previous reports, whereas one of the least common causes of TBI was motor vehicle collisions.[5,17,19]

Limitations

There are some limitations to this study. First, this is a retrospective study. Second, this was a single-center study even though 3 years of data was analyzed. This may have affected our results due to local treatment protocols. The mortality rate in the present study was very low; therefore, our results may not be applicable to other hospitals and populations with other conditions. For these reasons, the results should be validated with large-scale prospective studies.

CONCLUSIONS

In the present study, we compared the Rotterdam and Helsinki CT scoring systems. The use of such CT scoring systems for geriatric patients presenting with TBI allows us to predict the 30-day mortality. These two scoring systems have high sensitivity and can be used for geriatric patients presenting with TBI but there is no superiority to each other. Further studies are needed to support this evidence..

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Umraniye Training and Research Hospital Ethical Committee (ethics committee approval number: B.10.1TKH.4.34.H.GP.0.01/294).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

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